UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER
THORNEWELL, KIMBERLY A

ART UNIT	PAPER NUMBER
2128	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

	Application No.	Applicant(s)
Office Action Summary	10/621,472	GORDON, RONALD L.
	Examiner	Art Unit	
	Kimberly Thornewell	2128	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.
- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 July 2003*.

2a)☐ This action is **FINAL**.   2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28* is/are pending in the application.

   4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 May 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

   Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

   Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   a)☐ All   b)☐ Some * c)☐ None of:

   1.☐ Certified copies of the priority documents have been received.

   2.☐ Certified copies of the priority documents have been received in Application No. _____.

   3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

   * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *7/17/03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1.   Claims 1-28 have been presented for examination.

Information Disclosure Statement

2.   The information disclosure statement (IDS) submitted on 7/17/2003 is in compliance

with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being

considered by the examiner.

Claim Rejections - 35 USC § 112

3.   The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the
> subject matter which the applicant regards as his invention.

4.   Claims 9, 10, 23, and 24 are rejected under 35 U.S.C. 112, second paragraph, as being

indefinite for failing to particularly point out and distinctly claim the subject matter which

applicant regards as the invention. Claims 9 and 23 recite the limitation "said TCC integral" in

line 2. There is insufficient antecedent basis for this limitation in the claim. Claims 10 and 24

are rejected because of their dependence on claims 9 and 23, respectively.

Claim Rejections - 35 USC § 101

5.   35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or
> any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and
> requirements of this title.

6.   Claims 1-28 are rejected under 35 U.S.C. 101 because the claimed invention is directed

to non-statutory subject matter. The claimed ideas are abstract in nature. The Applicant has not

set forth a tangible invention. Claim 1 is directed to carrying out a series of mathematical

functions in order to obtain a transmission cross-coefficient. Because the TCC, after being

determined, is not stored, displayed, or otherwise conveyed through some form of transmission,

it is considered to be intangible. Furthermore, the steps in the method of claim 1 lack a physical

transformation, as they are drawn to mathematical calculations. Consequently, the method of

claim 1 is deemed non-statutory. Dependent claims 2-14 do not overcome the deficiencies of

claim 1, as they either clarify the steps of claim 1, or include additional steps lacking either

tangible results or physical transformations.

Claim 15 is directed to a computer program product instructions that, when executed,

perform a method similar to that of claim 1. Therefore the method steps in claim 15, like those

of claim 1, lack either a tangible result or a physical transformation. Furthermore, the Applicant

has not set forth any tangible embodiments of the computer program product itself in the

disclosure. Therefore the claim is interpreted as being software, per se. Dependent claims 16-28

do not overcome the deficiencies of claim 15, as they either clarify the steps of claim 15, or

include additional steps lacking either tangible results or physical transformations.

Claim Rejections - 35 USC § 102

7.   The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the

basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8.   Claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25, and 26 are rejected under 35 U.S.C. 102(e) as

being anticipated by Socha, US Patent Application Publication no. 2002/0152452, as cited by the

Applicant.

As per claims 1 and 15, Socha discloses a method and a computer program product

containing instructions for simulating an image of a patterned mask having a mask function in

the spatial frequency domain (**paragraph 65**, use of Fourier Transform), the image to be formed

by a projection system having a defocus amount z along an optical axis, the projection system

including pupil optics (**paragraph 101 lines 1-3**), the method comprising:

- Providing a source function having a center spatial frequency coordinate (**page 5
  equation 15**);

- Providing a first paraxial pupil function of the pupil optics at a first offset relative
  to said center spatial frequency coordinate and providing a second paraxial pupil
  function of the pupil optics at a second offset relative to said center spatial
  frequency coordinate (**page 9 equation 26,** $K.sub.0$ and $K.sub.0*$, derivations of
  functions taught in equation 20);

- Forming an integrand comprising a product of functions including said source
  function, said first paraxial pupil function, and said second paraxial pupil function
  (**integrand in equation 26**);

- Defining an integration region spanning the intersection of said source function with said first and second paraxial pupil functions, said integration region having a boundary comprising a finite number of arcs (**equation 26**, sqrt (alpha^2 + beta ^2) less than sigma);

- Integrating said integrand for each of said finite number of arcs to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution (**page 9 equation 28**); and

- Determining a transmission cross-coefficient (TCC) comprising a sum of said finite number of contour integrals (**page 9 equation 29**).

As per claims 2 and 16,

Socha discloses the first and second paraxial pupil functions each having a phase term that is approximated by a second order Taylor expansion (**page 9 equation 21**).

As per claims 8 and 22,

Socha discloses the projection system having an NA between *about* 0.5 to 0.7 (**paragraph 78 lines 2-5**, NA=0.8).

As per claims 9 and 23,

Socha discloses determining image intensity in accordance with a Hopkins model using the TCC integral (**paragraph 61**).

As per claims 11 and 25,

Socha discloses determining an aberration pupil function comprising an exponential of a phase term, said phase term expressed by a closed form polynomial series with respect to a deviation epsilon.sub.w from a spherical lens, wherein said exponential is Taylor expanded in terms of said deviation epsilon.sub.w to a specified order, wherein said step of forming an integrand further comprises multiplying each of said first and second paraxial pupil functions by said aberration function **(page 9 equations 23, 24, 26)**.

As per claims 12 and 26,

Socha discloses the closed form polynomial series comprising Zernike polynomials **(paragraph 104)**.

Claim Rejections - 35 USC § 103

9.   The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10.   Claims 3 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Socha as applied to claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25, and 26 above, in view of Kintner, "Method for the Calculation of Partially Coherent Imagery," published in Applied Optics Vol. 17 No. 17, September 1978.

As per claims 3 and 17,

Although Socha discloses circular arcs, the reference does not teach expressly calculating

subtended arcs. Kintner teaches computing subtended angles within circles (**page 2751 figure 4**,

taught as theta), wherein the angles are relative to the center of the corresponding circle of the

arc.

It would have been obvious to one of ordinary skill in the art of mask pattern

optimization, at the time of the present invention, to modify Socha's image simulation with

Kintner's use of subtended angles. The motivation for doing so would have been to be able to

easily calculate the area of the intersection of the two circles in Socha's Figure 1 by computing

triangular areas when calculating a transmission cross coefficient (Kintner page 2750 last

paragraph-page 2750 first paragraph).

11.   Claims 13, 14, 27 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over

Socha as applied to claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25, and 26 above, in view of Arnison

et al., "A 3D Vectorial Optical Transfer Function Suitable for Arbitrary Pupil Functions,"

published by Elsevier Science, September 2002.

As per claims 13 and 27,

Socha does not disclose expressly determining apodization pupil functions. Arnison

discloses a method for determining an optical transfer function including determining an

apodization pupil function, comprising a factor representing amplitude variations across the pupil

(page 6 equation 14), and multiplying the paraxial pupil functions by the apodization pupil

function (page 5 equation 12).

It would have been obvious to one of ordinary skill in the art of mask pattern

optimization, at the time of the present invention, to modify Socha's image simulation with

Arnison's use of apodization pupil functions in order to determine a TCC. The motivation for

doing so would have been to be able to maximize performance by being able to achieve higher

resolution images (Arnison page 2 paragraph 1 lines 1-5).

As per claims 14 and 28,

Socha discloses the NA being greater than about 0.7 (**paragraph 78 lines 2-5**, NA=0.8).

Allowable Subject Matter

12.   Claims 4-7, 10, 18-21, and 24 are objected to as being dependent upon a rejected base

claim, but would be allowable if rewritten both in independent form including all of the

limitations of the base claim and any intervening claims, and in order to overcome the rejections

under Sections 101 and 112, second paragraph above.

13.   The following is a statement of reasons for the indication of allowable subject matter:

As per claims 4-7 and 18-21:

The best prior art of record regarding these claims is as follows:

- Socha as applied to claims 1, 2, 3, 8, 9, 11, 12, 15, 16, 17, 21, 22, 25, and 26

  above

- Kintner as applied to claims 3 and 17 above

- Arnison as applied to claims 13, 14, 27 and 28 above

- Fukuda, US Patent no. 6,329,112

Regarding claims 4 and 18, Socha discloses error terms and the desirability to keep them low, preferably below a predetermined error tolerance (**paragraph 87**), and evaluating over a large finite number of terms in order to reduce error (**paragraphs 86-87**). Kintner, Arnison and Fukuda disclose the calculation and benefits of subtended angles (Kintner **page 2751 figure 4; Arnison page 9 figure 6,** taught as beta; Fukuda **column 5 lines 10-17**). All four documents disclose forming integrands for computing transmission cross coefficients, and Kintner, Arnison and Fukuda disclose parameterizing the integrands in terms of the cosine of the subtended angle. However, none of the teach parametrerizing the integrand in terms of a *square root of one plus the cosine of the subtended angle*. There is no obvious motivation to combine the references to achieve or derive such a parameterization; hence the subject matter of the claims is considered allowable.

Claims 5-7 and 19-21 are allowable because of their respective dependences on claims 4 and 18.

As per claims 10 and 24,

The best prior art of record regarding these claims is as follows:

- Socha as applied to claims 1, 2, 3, 8, 9, 11, 12, 15, 16, 17, 21, 22, 25, and 26 above

- Smith et al., US Patent no. 5,828,455

- Neureuther et al., US Patent no. 7,030,997

Socha discloses the NA being greater than about 0.7 (**paragraph 78 lines 2-5**, NA=0.8).

Neureuther discloses image intensity being orthogonal to the optical axis (**column 9 lines 21-30**).

While all three references describe using nonparaxial correction factors (or OPC), the references

do not disclose the nonparaxial factor being of the form *(1+NA.sup.2g({right arrow over (x)},*

z).sup.2), where g(x) is g (x -> , z) = x -> (N A z) (1 + 9 4 256 8 N A 8 z 4). There is no

obvious motivation to combine the references to achieve or derive such a factor; hence the

subject matter of the claims is considered allowable.

Conclusion

14.   Any inquiry concerning this communication or earlier communications from the

examiner should be directed to Kimberly Thornewell whose telephone number is (571)272-6543.

The examiner can normally be reached on 8am-4:30pm M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's

supervisor, Kamini Shah can be reached on (571)272-2279. The fax phone number for the

organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent

Application Information Retrieval (PAIR) system. Status information for published applications

may be obtained from either Private PAIR or Public PAIR. Status information for unpublished

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like assistance from a USPTO Customer Service Representative or access to the automated

information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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KAT

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